U.S. Fish & Wildlife Service

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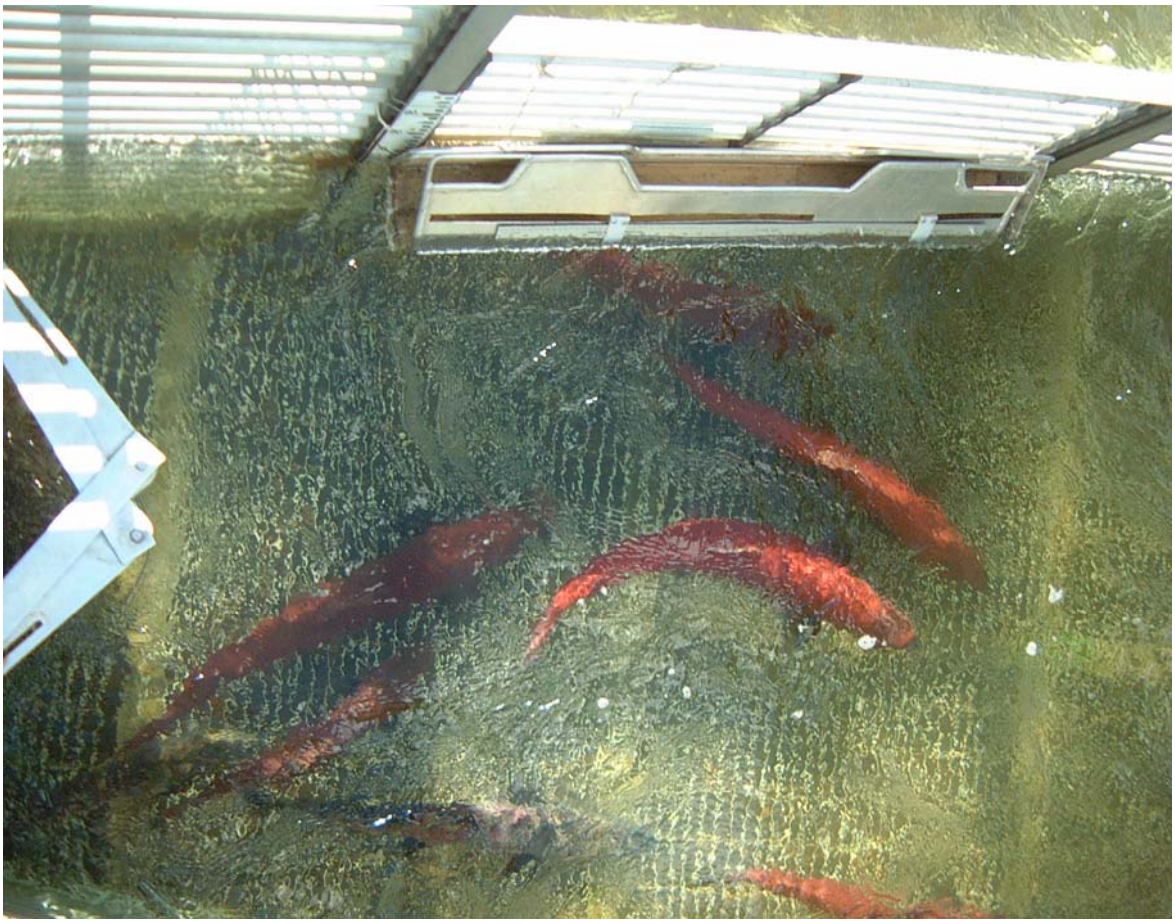

**Fairbanks Fish and Wildlife Field Office**
**Fairbanks, Alaska**
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# Abundance and Run Timing of Adult Salmon in Henshaw Creek, Kanuti National Wildlife Refuge, Alaska, 2004

**John P. O'Brien and Brandy L. Berkbigler**

## Abstract

During 2004, a resistance board weir was used to record escapement information from Chinook *Oncorhynchus tshawytscha* and chum salmon *O. keta* in Henshaw Creek, a tributary of the Koyukuk River, Alaska. An estimated total of 1,248 Chinook salmon migrated through the weir. Run timing for Chinook salmon was similar to the previous four years of weir operation. Five age groups were identified from 636 Chinook salmon sampled with age 1.2 (45%) dominating. The sex ratio was 23% female and 77% male. The mean length for 147 females was 807 mm, range 590-960 mm, and the mean length for 489 males was 645 mm, range 375-950 mm. An estimated total of 86,474 chum salmon migrated through the weir. The run timing for chum salmon was similar to the previous four years of weir operation. Three age groups were identified from 773 chum salmon sampled, with age 0.3 (86%) dominating. The sex ratio was 54% female and 46% male. The mean length for 421 females was 541 mm, range 450-655 mm, and the mean length for 352 males was 564 mm, range 460-670 mm. The most abundant non-salmon species was longnose sucker *Catostomus catostomus* (N=4,557), followed by Arctic grayling *Thymallus arcticus* (N=133), whitefish (Coregoninae) (N=94), and northern pike *Esox lucius* (N=26). Chinook and chum salmon escapement counts from this portion of the Koyukuk River drainage assist fisheries managers in making in-season decisions during the Yukon River commercial and subsistence fishing seasons, provide post-season evaluation of various management practices, and assist in developing future run projections.

## Introduction

The Yukon River drainage, encompassing 854,700 $km^2$, is among the largest producers of wild Chinook *Oncorhynchus tshawytscha* and chum salmon *O. keta* stocks in North America (Daum and Osborne 1999). Chinook, chum, and coho salmon *O. kisutsh* use 1,931 km of the Yukon River and 675 km of the Koyukuk River for migration routes to spawning grounds (Buklis and Barton 1984; Bergstrom et al. 1995). The Yukon River is the only North American drainage that has two distinct runs of chum salmon, which are referred to as summer and fall runs (Vania et al. 2002). Genetic studies reported by Wilmot et al. (1992) showed that these two runs were genetically distinct and differed in life history and phenotypic characteristics, i.e. run timing, spawning locations, and morphology. Chinook and summer chum salmon run timing in the Yukon River starts in late May and continues through mid-July (Wiswar 2000). Fall chum salmon run timing starts in late June and continues through early September (Vania et al. 2002). Chinook salmon spawn throughout the Yukon River drainage, whereas summer chum salmon spawn mainly in the lower and middle reaches (Minard 1996). Fall chum salmon spawn mainly in the upper portions of the Yukon River drainage.

Recent declines in Yukon River salmon runs, particularly summer and fall chum salmon have led to harvest restrictions, complete fishery closures, and spawning escapements below management goals on many tributaries (Kruse 1998; Vania et al. 2002). The need to collect accurate

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escapement estimates from these tributaries is required to determine exploitation rates and spawner recruit relationships (Labelle 1994), as well as determining if genetic diversity and sustainable harvest are being provided for (Vania et al. 2002). Management of the Yukon River fishery is complex due to the inability to determine specific stock abundance and run timing, overlapping of multi-species salmon runs, the increasing efficiency of the fishing fleet, allocation issues, and the immense size of the Yukon River drainage. In an attempt to understand this mixed-stock salmon fishery, several studies are being conducted along the main stem and tributaries of the Yukon River to provide managers with information required to assess in-season Chinook and chum salmon escapements (Vania and Golembeski 2000).

In accordance with the Alaska National Interest Lands Conservation Act of 1980, the U.S. Fish and Wildlife Service (USFWS) is obligated to conserve the natural diversity of fish and wildlife resources on National Wildlife Refuge lands. Additional USFWS goals are to conserve fish and wildlife populations, maintain habitats in their natural diversity, and provide the opportunity for continued subsistence use by local residents (USFWS 1993a, b). In the Koyukuk River drainage (a middle Yukon River tributary), Chinook and summer chum salmon (hereafter referred to as chum salmon) utilize tributaries that run through National Wildlife Refuge boundaries. The Koyukuk River originates in the Brooks Range, and the river flows southwesterly, passing through the Kanuti and Koyukuk National Wildlife Refuges before entering the Yukon River, 818 km upriver from the mouth. The Kanuti Refuge is located on the upper Koyukuk River near the villages of Allakaket, Alatna, and Bettles. The Koyukuk Refuge is located on the lower Koyukuk River near the villages of Koyukuk, Galena, Huslia, and Hughes.

Historically, escapement information on salmon stocks from the Koyukuk River has been collected by aerial surveys. The Alaska Department of Fish and Game, Division of Commercial Fisheries (ADF&G-DCF) has conducted these surveys on several index tributaries within the Koyukuk River drainage intermittently since 1960 (Barton 1984). Unfortunately, aerial surveys are highly variable and only represent an index of instantaneous escapement. To record total escapements, aerial survey methods have been replaced with more accurate population assessment methods, such as counting towers, floating weirs, and riverine hydroacoustics. To collect baseline information on salmon stocks in the Koyukuk River drainage, the U.S. Fish and Wildlife Service-Fairbanks Fish and Wildlife Field Office (USFWS-FFWFO) and the Bureau of Land Management (BLM) have designed and operated stock status and escapement projects in five different Koyukuk River tributaries. Floating weirs have been operated by USFWS-FFWFO on the Gisasa River since 1994 (VanHatten 2002), on Henshaw Creek since 2000 (VanHatten 2002), the South Fork of the Koyukuk River from 1996-1997 (Wiswar 1997, 1998) and on the Kateel River in 2002 (VanHatten 2002). The weir study on the South Fork of the Koyukuk River was discontinued in 1997 due to persistent high water conditions. A counting tower was operated by the Tanana Chiefs Conference (TCC) and BLM on Clear Creek, a tributary of the Hogatza River, from 1995 to 2000 (VanHatten 1999). A standard pickett weir was installed on Clear Creek in 2001 and is currently in operation (C. Kretsinger, Bureau of Land Management, Fairbanks, personal communication).

Historically from 1969-1998, aerial survey counts of Chinook salmon ranged from six fish in 1969 to 561 fish in 1986 and chum salmon counts ranged from 12 fish in 1982 to 24,780 fish in 1996 (Barton 1984; Schultz et al. 1993; Vania et al. 2002; Appendix 1). A counting tower was operated on Henshaw Creek in 1999. However, due to high water conditions during a three-week period, only a partial count of 12 Chinook and 1,510 chum salmon was obtained (VanHatten 1999). In 2000 a resistance board weir was installed and operated by USFWS-

FFWFO during the full season. The weir counted 244* Chinook and 27,271* chum salmon in 2000 (USFWS 2005); 1,103* Chinook and 35,031* chum salmon in 2001 (VanHatten 2002); 649 Chinook and 25,249 chum salmon in 2002 (VanHatten 2005); 763* Chinook and 22,556** chum salmon in 2003 (Vanhatten and Voight 2005); and 1,248 Chinook and 86,474 chum salmon in 2004 (Figure 3).

This report describes the 2004 USFWS-FFWFO weir escapement project conducted in Henshaw Creek. The objectives of the project were to (1) determine daily escapement and run timing of adult salmon, (2) gather age, sex, and size composition data from passing adult salmon, and (3) monitor non-salmon species movement through the weir.

## Study Area

Climate conditions of the Koyukuk River drainage are characteristically continental with seasonal variations in temperature and very low precipitation. The air temperature ranges from 18° C in summer to -57° C in winter (USFWS 1993a). The hydrology of this area is very dynamic throughout the year with high water levels during spring and low water levels in summer. The lower Koyukuk River sections are characteristically uniform in appearance with gradual sloping mud banks and emergent shoreline vegetation (USFWS 1993a). The substrate composition along the river varies from gravel and cobble in high velocity sections to mud and silt in eddies and sloughs.

Henshaw Creek is located on the upper Koyukuk River, 753 km upriver from the mouth of the Koyukuk River (Figure 1). The headwaters of Henshaw Creek originate in the Alatna Hills and the river flows 144 km southeast, passing through the Kanuti Refuge, before entering the Koyukuk River (66° 33' N latitude, 152° 13' W longitude, USGS 1:63,360 series, Bettles C-5 quadrangle). The location of the weir site is approximately 1.5 km upriver from the mouth of Henshaw Creek. This site was selected for its optimal width (29 m), depth (0.6 m), and substrate composition (small cobble, 50-150 mm diameter).

## Methods

*Weir Operation*

A resistance board weir was used to collect escapement counts and biological information from adult salmon as they migrated into Henshaw Creek to spawn. The start date of the project was based on previous years' run timing data. The end date of the project was determined in-season; when the daily count of each species dropped to less than 1% of the seasonal passage to date and continued at this low level for three or more consecutive days. The construction and installation of resistance board weirs was described by Tobin (1994). Each picket of the weir was made of schedule-40, polyvinyl chloride electrical conduit with 2.5 cm inside diameter and individual pickets spaced 3.2 cm apart, gap between pickets (Wiswar 2001). During daily visual inspection, the weir was cleaned of debris, fish carcasses, and gravel dislodged by spawning fish. A live trap installed near mid-channel allowed salmon and resident fish species to be recorded as they passed through the weir.

* Corrected cumulative count.

*Biological Data*

Run timing and abundance of adult Chinook and chum salmon were estimated by recording and plotting the number of each species of fish passing through the weir each day. Because non-salmon species were not handled, it was difficult to identify different whitefish species. Therefore, all whitefish were grouped under the subfamily Coregoninae. Fish that could not be identified as they passed through the weir were grouped in a separate category, labeled "other".

The daily counting schedule was dependent upon the level of fish passage through the weir. During the beginning and end of the run, when hourly counts were low, counting was conducted between 0800 and 2400 hours, with the trap closed from 2400 to 0800 hours to prevent upstream passage during unmonitored times. As the run increased in strength, the counting schedule increased to 24 hours a day, 7 days a week.

A stratified random sampling scheme was used to collect age, length, and sex ratio information from both adult salmon species. Sampling started at the beginning of each week and generally was conducted over a 3-4 day period, targeting 160 salmon /species /week. Scales were used for ageing salmon with age class information being reported using the European technique (Foerster 1968). Three scales were collected from Chinook salmon and one scale from chum salmon. Scales were sampled from the area located on the left side of the fish and two rows above the lateral line on a diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin. Scales from both adult salmon species were sent to ADF&G-DCF for processing. Lengths of Chinook and chum salmon were measured to the nearest 5 mm from mid-eye to fork of the caudal fin (MEL). Sex ratio data were collected during age and length sampling. Sex of each fish was visually determined by secondary sex characteristics. Daily escapement counts and sex ratios were reported to USFWS-FFWFO in Fairbanks.

*Data Analysis*

When daily counts were missed due to high water, the missing daily counts were estimated by linear interpolation between the daily count before and after the high water event. Incomplete 24-h counts due to high water were adjusted for a 24-h period.

Calculations for age and sex information were treated as a stratified random sample (Cochran 1977) with statistical weeks as the strata. Each statistical week was defined as beginning on Wednesday and ending on Tuesday. Within a week, the proportion of the samples composed of a given sex or age, $\hat{p}_{ij}$, were calculated as

$$\hat{p}_{ij} = \frac{n_{ij}}{n_j},$$

where $n_{ij}$ is the number of fish by sex *i* or age *i* sampled in week *j*, and $n_j$ is the total number of fish sampled in week *j*. The variance of $\hat{p}_{ij}$ was calculated as

$$\hat{v}(\hat{p}_{ij}) = \frac{\hat{p}_{ij}(1-\hat{p}_{ij})}{n_j - 1}.$$

Sex and age compositions for the total run of Chinook and chum salmon of a given sex/age, $\hat{p}_i$ were calculated as

$$\hat{p}_i = \sum_{j-1} \hat{W}_j \hat{p}_{ij,}$$

where the stratum weight $\hat{W}_j$ was calculated as

$$\hat{W}_j = \frac{N_j}{N},$$

and $N_j$ equals the total number of fish of a given species passing through the weir during week $j$, and $N$ is the total number of fish of a given species passing through the weir during the run. Variance, $\hat{v}(\hat{p}_i)$ of sex and age compositions for the run was calculated as

$$\hat{v}(\hat{p}_i) = \sum_{j-1} \hat{W}_j^2 \hat{v}(\hat{p}_{ij}).$$

## Results

*Weir Operation*

In 2004, the Henshaw Creek weir was effective in allowing fish passage and as an aid in collecting biological information. The spacing between each weir picket (3.2 cm) prevented adult Chinook and chum salmon from passing through the weir panels. However, small individuals of some non-salmon species, such as Arctic grayling *Thymallus arcticus*, longnose sucker *Catostomus catostomus*, northern pike *Esox lucius*, and whitefish (Coregoninae), likely passed undetected through the weir.

*Biological Data*

The weir was installed on June 20 and operated through August 6. There were no missed daily counts during the season. A total of 1,248 Chinook salmon, 86,474 chum salmon were counted as they passed through the weir (Table 1). The most abundant non-salmon species was longnose sucker (N=4,557), followed by Arctic grayling (N=133), whitefish (N=94), and northern pike (N=26).

The first Chinook salmon arrived on June 29 and on the last day of operation, August 6, two Chinook salmon were counted (Table 1; Figure 2). The first quartile migrated through the weir by July 10, the median migration date was July 12, and the third quartile passed the weir on July 16. There were 636 Chinook salmon sampled for age composition with 34 (5%) of the samples classified as unknown (Table 2). Age composition of sampled Chinook salmon included five age groups: age 1.1 (<1%), age 1.2 (45%), age 1.3 (28%), age 1.4 (26%), and age 1.5 (1%). The Chinook salmon sex composition consisted of 23% females (Table 3). The age distribution by sex was unevenly divided among the five age groups with age 1.4 dominating the females (73%) and ages 1.2 (56%) and 1.3 (32%) dominating the males (Table 4). The average female Chinook salmon length was 807 mm with a range of 590-960 mm MEL (Table 5). The average male Chinook salmon length was 645 mm with a range of 375-950 mm MEL.

The first chum salmon arrived on June 21 and on the last day of operation, August 6, 508 chum salmon were counted (Table 1; Figure 2). The first quartile migrated through the weir by July 13, the median migration date was July 18, and the third quartile passed the weir on July 21. There were 773 chum salmon sampled for age composition with 81 (10%) of the sample classified as unknown (Table 6). Age composition of sampled chum salmon consisted of three age groups: age 0.2 (7%), age 0.3 (86%) and, age 0.4 (7%). The chum salmon sex composition consisted of 54% females (Table 7). The age distribution by sex was unevenly divided among the three age groups with age 0.3 dominating both females (85%) and males (86%; Table 8). The average female chum salmon length was 541 mm with a range of 450-655 mm MEL (Table 5). The average male chum salmon length was 564 mm with a range of 460-670 mm MEL.

## Discussion

*Escapement and Run timing*

In 2004, the Chinook salmon escapement of 1,248 was the largest out of the 5 years of weir operation (Figure 3; Appendix 1). The next largest run size occurred in 2001 (VanHatten 2002; N=1,103), followed by 2003 (VanHatten and Voight 2005; N=763), 2002 (VanHatten 2005; N=649) and 2000 (USFWS 2005; N=244).

Similar to the Chinook salmon run, the chum salmon escapement of 86,474 in 2004 was the largest by far in the five years of weir operation (Figure 3; Appendix 1). The next largest chum escapement occurred in 2001 (VanHatten 2002; N=35,031), followed by 2000 (USFWS 2005; N=27,271), 2002 (VanHatten 2005; N=25,249), and 2003 (VanHatten and Voight 2005; N=22,556).

Chinook salmon run timing was similar between the 5 years of weir operations. The first quartile of the Chinook salmon run passed the weir between July 10 and July 15 (Table 1). The range of median passage dates for Chinook salmon for the 5 years of weir operation was July 12-19. The range of third quartile passage dates for Chinook salmon for the five years of operations was July 16-21. The chum salmon run timing was also similar for the 5 years of weir operation. The range of first quartile dates for chum salmon from 2000-2004 was July 13-18, median July 15-22, and third quartile July 19-25 (USFWS 2005; VanHatten 2002; VanHatten 2005; VanHatten and Voight 2005). The variation in run timing among years for both salmon species was typical of other stocks in the Koyukuk River system (VanHatten 2002).

*Age Distribution*

In general, Chinook salmon populations are made up of six age classes, with age 1.4 fish dominating (Groot and Margolis 1998). In Henshaw Creek in 2004, however, age 1.2 Chinook were most numerous in 5 out of 7 weekly sampling strata and accounted for 45% of the total run (Table 2). Fifty-six percent of all males sampled were 1.2 year olds but only 8% of all females were in this age class (Table 4). Age class 1.4 had the highest proportion of female Chinook salmon (73%). This age distribution differs from 2001 when the most abundant age class was 1.4 (VanHatten 2002) and from 2000 (USFWS 2005), 2002 (VanHatten 2005) and 2003 (VanHatten and Voight 2005) when age class 1.3 was most numerous (Appendix 2).

In North America, chum salmon populations generally are comprised of four age classes, with age 0.3 fish dominating (Groot and Margolis 1998). Based on the sampled population, 86% of the 2004 Henshaw Creek chum salmon run was composed of age 0.3 fish (Table 6). This was also the most abundant age class in 2003 (VanHatten and Voight 2005; Appendix 3). In 2001

and 2002, 0.4 year old chum salmon were numerically prominent (VanHatten 2002; 2005). In 2000, both age 0.3 (57%) and age 0.4 (42%) chum salmon dominated the run (USFWS 2005). The dominant age class in terms of overall abundance has varied between age class 0.3 and 0.4 for this population.

*Sex Ratio*

A high proportion of females on the spawning ground is indicative of the general health and productivity of a salmon population (Groot and Margolis 1998). In addition, during a given spawning period there are typically higher proportions of males in early stages of the run while females dominate later stages (Beacham and Starr 1982). Chinook sampled at Henshaw Creek in 2004 were atypical in that the highest proportion of females (42%) arrived in week two of weir operation and declined thereafter (Table 3). The total proportion of females in the 2004 Chinook sample (23%) is the lowest on record since 2000 (20% female; USFWS 2005; Appendix 4).

The proportion of female chum salmon sampled in Henshaw Creek in 2004 was 54% which was the second lowest percentage of returning females after 2003 (50%; VanHatten and Voight 2005; Appendix 5). Weekly sex ratios were low for females (43%) at the outset of weir operation for 2004 but increased steadily throughout the run to 60% female during the final week (Table 7).

*Length*

The average MEL for female Chinook in 2004 was the lowest out of all five years of operation of Henshaw Creek weir (Appendix 6). The 2004 average MEL for male Chinook sampled at Henshaw Creek was the second highest after 2001 (VanHatten 2002).

The average MEL for female chum salmon of Henshaw Creek in 2004 was 541 mm, the third highest after 2002 (VanHatten 2005; 556 mm) and 2001 (VanHatten 2002; 549 mm) for the five years of weir operation (Appendix 7). The average MEL for male chum salmon in 2004 was 564 mm, which was the lowest for the five years of weir operation on Henshaw Creek.

Due to the complexity of the Yukon River mixed-stock salmon fishery and the difficulty in managing specific stocks, it is essential to continue collecting information from individual salmon populations, including stocks in the Koyukuk River drainage. It is recommended that the three current enumeration projects in the drainage at Henshaw Creek, Clear Creek and Gisasa River provide a valuable index of salmon escapement, and as such, should be continued. In addition, these projects allow population status, trends and changes to be monitored and analyzed over a long time-series.

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**Table 1. Daily and cumulative (Chinook and chum salmon only) count of fish passing through Henshaw Creek weir, Alaska, 2004. (Cum=cumulative). * indicates first, middle, and third quartile of run.**

| | Chinook salmon | | Summer chum salmon | | Longnose sucker | Arctic grayling | Northern pike | Whitefish spp. | Other[a] |
|---|---|---|---|---|---|---|---|---|---|
| Date | Daily | Cum | Daily | Cum | Daily | Daily | Daily | Daily | Daily |
| 20-Jun | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 21-Jun | 0 | 0 | 2 | 2 | 9 | 4 | 0 | 2 | 0 |
| 22-Jun | 0 | 0 | 6 | 8 | 8 | 2 | 0 | 0 | 3 |
| 23-Jun | 0 | 0 | 2 | 10 | 18 | 0 | 0 | 5 | 0 |
| 24-Jun | 0 | 0 | 6 | 16 | 24 | 0 | 0 | 0 | 0 |
| 25-Jun | 0 | 0 | 59 | 75 | 4 | 0 | 0 | 0 | 0 |
| 26-Jun | 0 | 0 | 77 | 152 | 13 | 2 | 0 | 0 | 0 |
| 27-Jun | 0 | 0 | 95 | 247 | 95 | 1 | 0 | 2 | 1 |
| 28-Jun | 0 | 0 | 128 | 375 | 125 | 4 | 0 | 0 | 0 |
| 29-Jun | 1 | 1 | 199 | 574 | 214 | 0 | 2 | 0 | 1 |
| 30-Jun | 1 | 2 | 45 | 619 | 610 | 1 | 0 | 0 | 1 |
| 1-Jul | 4 | 6 | 102 | 721 | 362 | 1 | 1 | 3 | 0 |
| 2-Jul | 12 | 18 | 177 | 898 | 383 | 1 | 0 | 3 | 0 |
| 3-Jul | 1 | 19 | 528 | 1,426 | 175 | 4 | 1 | 1 | 1 |
| 4-Jul | 15 | 34 | 1,028 | 2,454 | 145 | 5 | 0 | 0 | 0 |
| 5-Jul | 17 | 51 | 1,543 | 3,997 | 201 | 0 | 0 | 0 | 0 |
| 6-Jul | 32 | 83 | 2,339 | 6,336 | 32 | 4 | 0 | 0 | 0 |
| 7-Jul | 56 | 139 | 2,115 | 8,451 | 31 | 1 | 0 | 0 | 0 |
| 8-Jul | 41 | 180 | 2,811 | 11,262 | 38 | 3 | 0 | 0 | 1 |
| 9-Jul | 80 | 260 | 3,089 | 14,351 | 52 | 4 | 1 | 0 | 1 |
| 10-Jul | 122 | *382 | 2,629 | 16,980 | 42 | 6 | 2 | 0 | 0 |
| 11-Jul | 174 | 556 | 2,299 | 19,279 | 579 | 0 | 5 | 2 | 0 |
| 12-Jul | 84 | *640 | 1,582 | 20,861 | 251 | 3 | 1 | 0 | 0 |
| 13-Jul | 58 | 698 | 2,774 | *23,635 | 125 | 0 | 0 | 1 | 0 |
| 14-Jul | 65 | 763 | 4,314 | 27,949 | 86 | 7 | 1 | 0 | 0 |
| 15-Jul | 96 | 859 | 4,730 | 32,679 | 135 | 3 | 1 | 0 | 1 |
| 16-Jul | 112 | *971 | 4,916 | 37,595 | 102 | 3 | 1 | 1 | 0 |
| 17-Jul | 51 | 1,022 | 5,578 | 43,173 | 67 | 2 | 0 | 0 | 0 |
| 18-Jul | 31 | 1,053 | 7,087 | *50,260 | 43 | 3 | 1 | 1 | 0 |
| 19-Jul | 39 | 1,092 | 6,420 | 56,680 | 18 | 4 | 0 | 0 | 0 |
| 20-Jul | 17 | 1,109 | 5,159 | 61,839 | 119 | 12 | 1 | 2 | 0 |
| 21-Jul | 23 | 1,132 | 3,935 | *65,774 | 156 | 13 | 1 | 0 | 0 |
| 22-Jul | 16 | 1,148 | 2,970 | 68,744 | 29 | 8 | 2 | 0 | 0 |
| 23-Jul | 11 | 1,159 | 2,774 | 71,518 | 11 | 4 | 1 | 0 | 1 |
| 24-Jul | 14 | 1,173 | 2,583 | 74,101 | 2 | 4 | 1 | 0 | 0 |
| 25-Jul | 13 | 1,186 | 2,091 | 76,192 | 6 | 6 | 1 | 1 | 0 |
| 26-Jul | 7 | 1,193 | 1,583 | 77,775 | 10 | 1 | 0 | 4 | 1 |
| 27-Jul | 6 | 1,199 | 1,198 | 78,973 | 14 | 0 | 0 | 16 | 0 |
| 28-Jul | 9 | 1,208 | 942 | 79,915 | 3 | 1 | 0 | 6 | 1 |
| 29-Jul | 4 | 1,212 | 842 | 80,757 | 8 | 0 | 0 | 2 | 0 |
| 30-Jul | 7 | 1,219 | 960 | 81,717 | 11 | 1 | 0 | 5 | 1 |
| 31-Jul | 2 | 1,221 | 865 | 82,582 | 7 | 1 | 0 | 6 | 1 |
| 1-Aug | 5 | 1,226 | 792 | 83,374 | 3 | 0 | 2 | 0 | 0 |
| 2-Aug | 10 | 1,236 | 937 | 84,311 | 5 | 2 | 2 | 0 | 1 |
| 3-Aug | 5 | 1,241 | 609 | 84,920 | 27 | 4 | 4 | 1 | 0 |
| 4-Aug | 3 | 1,244 | 408 | 85,328 | 103 | 7 | 4 | 0 | 0 |
| 5-Aug | 2 | 1,246 | 638 | 85,966 | 37 | 1 | 15 | 0 | 0 |
| 6-Aug | 2 | 1,248 | 508 | 86,474 | 19 | 0 | 4 | 0 | 0 |
| Total | 1,248 | | 86,474 | | 4,557 | 133 | 94 | 26 | 16 |

Other[a] = unidentified

**Table 2. Percent weekly and seasonal age estimates of Chinook salmon sampled at Henshaw Creek weir, Alaska, 2004. Standard errors are in parentheses. Season totals are calculated from weighted weekly estimates.**

| | | | | Brood year and age | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 2001 | 2000 | 1999 | 1998 | 1997 |
| Time period | Run size (N) | Sample size (n) | Unknown | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 |
| Jun 21-27 | 0 | | | | | | | |
| Jun 28-Jul 4 | 34 | 24 | 0 | 0 (0.0) | 42 (10.3) | 42 (10.3) | 13 (6.9) | 4 (4.2) |
| Jul 5-11 | 522 | 349 | 20 | 0 (0.0) | 45 (2.7) | 30 (2.4) | 26 (2.3) | 0 (0.3) |
| Jul 12-18 | 497 | 162 | 10 | 0 (0.0) | 42 (3.9) | 28 (3.5) | 29 (3.6) | 1 (0.9) |
| Jul 19-25 | 133 | 66 | 3 | 0 (0.0) | 56 (6.2) | 14 (4.3) | 30 (5.7) | 0 (0.0) |
| Jul 26-Aug 1 | 40 | 21 | 0 | 0 (0.0) | 52 (11.2) | 33 (10.5) | 14 (7.8) | 0 (0.0) |
| Aug 2-6 | 22 | 14 | 1 | 7 (7.1) | 36 (13.3) | 43 (13.7) | 14 (9.7) | 0 (0.0) |
| Total | 1,248 | 636 | 34 | 0 (0.1) | 45 (2.1) | 28 (1.9) | 26 (1.9) | 1 (0.4) |

**Table 3. Percent weekly and seasonal Chinook salmon sex ratios sampled at Henshaw Creek weir, Alaska, 2004. Standard errors are in parentheses. Season totals are calculated from weighted weekly estimates.**

| Time period | Run size (N) | Sample size (n) | Percent female |
|---|---|---|---|
| Jun 21-27 | 0 | | |
| Jun 28-Jul 4 | 34 | 24 | 42 (10.3) |
| Jul 5-11 | 522 | 349 | 23 (2.3) |
| Jul 12-18 | 497 | 162 | 20 (3.1) |
| Jul 19-25 | 133 | 66 | 29 (5.6) |
| Jul 26-Aug 1 | 40 | 21 | 19 (8.8) |
| Aug 2-6 | 22 | 14 | 7 (7.1) |
| Total | 1,248 | 636 | 23 (1.7) |

**Table 4. Percent seasonal sex contribution by age of Chinook salmon sampled at Henshaw Creek weir, Alaska, 2004. Standard errors are in parentheses.**

| | | | | | Brood year and age | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2001 | 2000 | 1999 | 1998 | 1997 |
| Sex | Run size (N) | Sample size (n) | Unknown | Percent sex per season | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 |
| Female | 281 | 147 | 12 | 23 | 0 (0.0) | 8 (2.5) | 16 (2.1) | 73 (3.5) | 3 (1.8) |
| Male | 967 | 489 | 22 | 77 | 0 (0.1) | 56 (2.3) | 32 (2.2) | 11 (1.6) | 0 (0.0) |

**Table 5. Length at age of female and male Chinook and chum salmon sampled at Henshaw Creek weir, Alaska, 2004.**

| | Female | | | | | Male | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Mid-eye to fork length (mm) | | | | | Mid-eye to fork length (mm) | | | |
| Age | n | Mean | Median | SE | Range | n | Mean | Median | SE | Range |
| | | | | | **Chinook salmon** | | | | | |
| 1.1 | 0 | | | | | 1 | 375 | 375 | --- | --- |
| 1.2 | 12 | 644 | 645 | 9.3 | 590-690 | 275 | 583 | 585 | 2.6 | 400-680 |
| 1.3 | 23 | 704 | 700 | 10.6 | 630-810 | 157 | 689 | 700 | 5.0 | 520-880 |
| 1.4 | 108 | 845 | 840 | 3.5 | 750-960 | 56 | 827 | 838 | 7.7 | 715-950 |
| 1.5 | 4 | 880 | 905 | 34.4 | 780-930 | 0 | | | | |
| Total | 147 | 807 | 830 | 6.7 | 590-960 | 489 | 645 | 620 | 4.4 | 375-950 |
| | | | | | **chum salmon** | | | | | |
| 0.2 | 36 | 516 | 515 | 4.6 | 460-580 | 21 | 540 | 535 | 7.0 | 490-600 |
| 0.3 | 359 | 542 | 540 | 1.4 | 450-655 | 302 | 562 | 560 | 1.6 | 460-670 |
| 0.4 | 26 | 558 | 560 | 5.6 | 500-600 | 29 | 604 | 600 | 4.3 | 570-655 |
| Total | 421 | 541 | 540 | 1.4 | 450-655 | 352 | 564 | 560 | 1.6 | 460-670 |

**Table 6. Percent weekly and seasonal age estimates of summer chum salmon sampled at Henshaw Creek weir, Alaska, 2004. Standard errors are in parentheses. Season totals are calculated from weighted weekly estimates.**

| | | | | Brood year and age | | |
|---|---|---|---|---|---|---|
| | | | | 2001 | 2000 | 1999 |
| Time period | Run size (N) | Sample size (n) | Unknown | 0.2 | 0.3 | 0.4 |
| Jun 21-27 | 247 | 7 | 0 | 0 (0.0) | 29 (18.4) | 71 (18.4) |
| Jun 28-Jul 4 | 2,207 | 113 | 10 | 11 (2.9) | 74 (4.1) | 15 (3.4) |
| Jul 5-11 | 16,825 | 150 | 14 | 4 (1.6) | 88 (2.7) | 8 (2.2) |
| Jul 12-18 | 30,981 | 106 | 14 | 5 (2.1) | 88 (3.2) | 8 (2.6) |
| Jul 19-25 | 25,932 | 144 | 16 | 8 (2.2) | 89 (2.6) | 3 (1.5) |
| Jul 26-Aug 1 | 7,182 | 148 | 12 | 10 (2.5) | 87 (2.8) | 3 (1.3) |
| Aug 2-6 | 3,100 | 105 | 15 | 8 (2.6) | 89 (3.1) | 4 (1.9) |
| Total | 86,474 | 773 | 81 | 7 (1.1) | 86 (1.5) | 7 (1.1) |

**Table 7. Percent weekly and seasonal summer chum salmon sex ratios sampled at Henshaw Creek weir, Alaska, 2004. Standard errors are in parentheses. Season totals are calculated from weighted weekly estimates.**

| Time period | Run size (N) | Sample size (n) | Percent female |
|---|---|---|---|
| Jun 21-27 | 247 | 7 | 43 (20.2) |
| Jun 28-Jul 4 | 2,207 | 113 | 55 (4.7) |
| Jul 5-11 | 16,825 | 150 | 45 (4.1) |
| Jul 12-18 | 30,981 | 106 | 54 (4.9) |
| Jul 19-25 | 25,932 | 144 | 58 (4.1) |
| Jul 26-Aug 1 | 7,182 | 148 | 57 (4.1) |
| Aug 2-6 | 3,100 | 105 | 60 (4.8) |
| Total | 86,474 | 773 | 54 (2.3) |

**Table 8. Percent seasonal sex contribution of summer chum salmon sampled at Henshaw Creek weir, Alaska, 2004. Standard errors are in parentheses.**

| | | | | | Brood year and age | | |
|---|---|---|---|---|---|---|---|
| | | | | | 2001 | 2000 | 1999 |
| Sex | Run size (N) | Sample size (n) | Unknown | Percent sex per season | 0.2 | 0.3 | 0.4 |
| Female | 46,535 | 421 | 43 | 54 | 9 (1.5) | 85 (2.0) | 6 (1.5) |
| Male | 39,939 | 352 | 38 | 46 | 6 (1.6) | 86 (2.3) | 8 (1.7) |

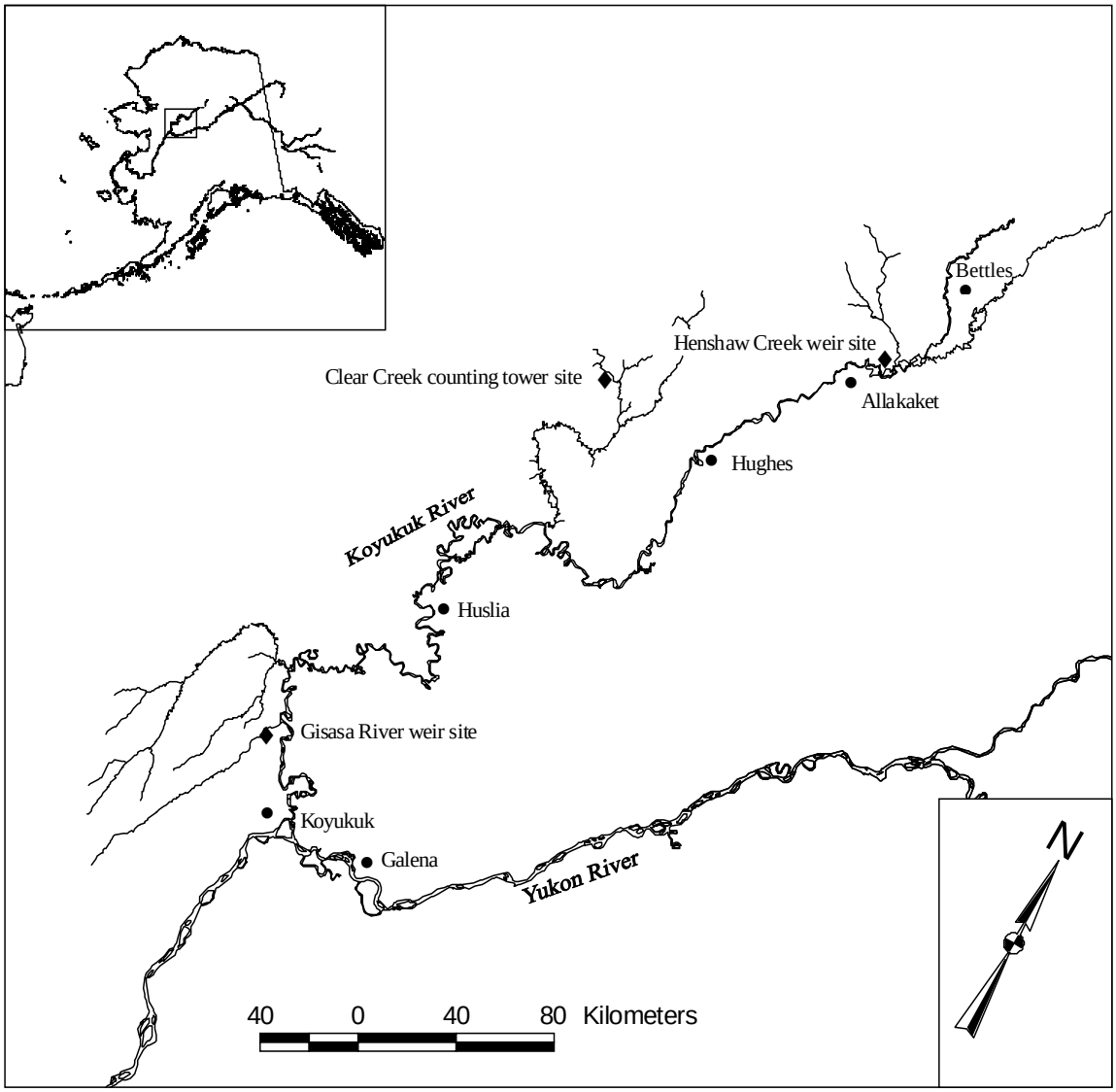


**Figure 1. The Koyukuk River, Henshaw Creek and other tributary escapement study sites (♦), Alaska, 2004.**

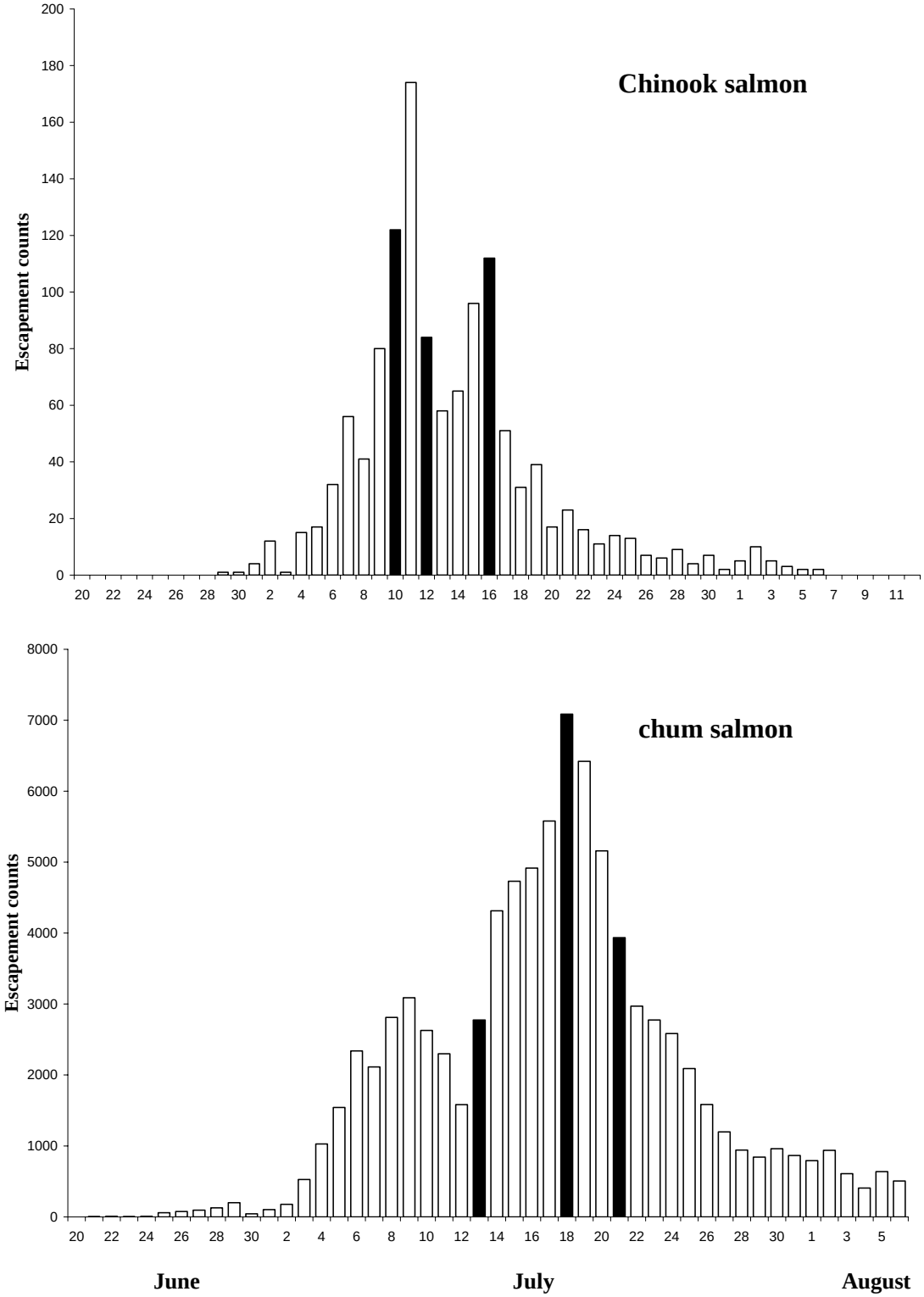


**Figure 2. Daily escapement counts of Chinook salmon and summer chum salmon recorded at Henshaw Creek Weir, Alaska, 2004. Shaded areas represent first, middle, and third quartile of run.**

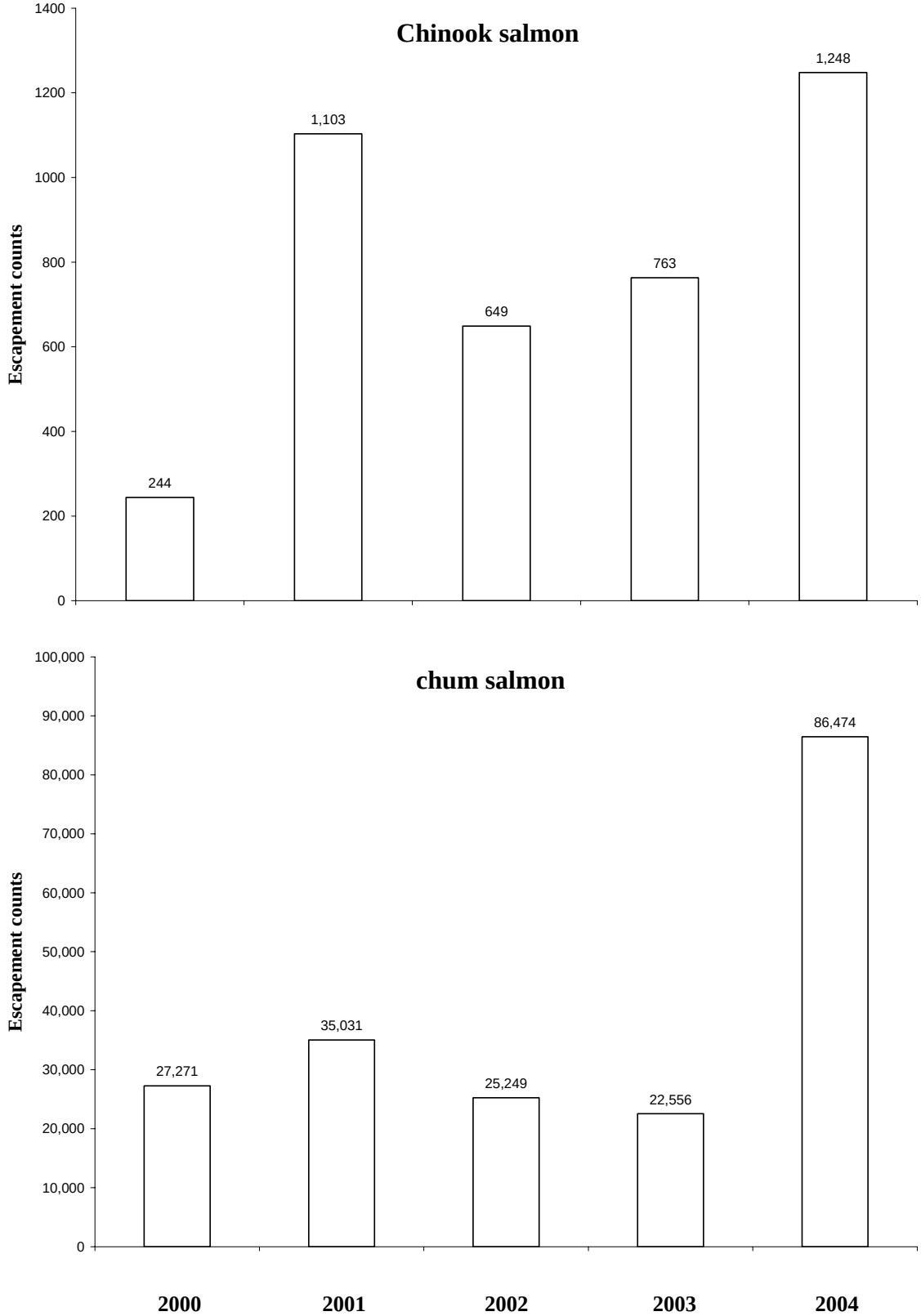


**Figure 3. Chinook and chum salmon ecapement counts recorded at Henshaw Creek weir, Alaska, 2000-2004.**

**Appendix 1. Historical Chinook and summer chum salmon escapements for Henshaw Creek, Alaska, 1969-2004. * indicates partial tower count in 1999.**

| | Aerial index estimates | | | Counting tower | | Weir | |
|---|---|---|---|---|---|---|---|
| Year | Chinook salmon | Chum salmon | Rating | Chinook salmon | Chum salmon | Chinook salmon | Chum salmon |
| 1969 | 6 | 300 | Not rated | | | | |
| 1975 | 118 | 1,219 | Not rated | | | | |
| 1976 | 94 | 624 | Fair | | | | |
| 1982 | 48 | 12 | Fair | | | | |
| 1983 | 551 | 3,289 | Good | | | | |
| 1984 | 253 | 532 | Poor | | | | |
| 1985 | 393 | 3,724 | Good | | | | |
| 1986 | 561 | 2,475 | Fair | | | | |
| 1987 | 20 | 35 | Not rated | | | | |
| 1988 | 180 | 1,106 | Good-poor | | | | |
| 1990 | 369 | 1,237 | Good-fair | | | | |
| 1991 | 455 | 2,148 | Good | | | | |
| 1994 | 526 | 2,165 | Fair | | | | |
| 1996 | 138 | 24,780 | Fair | | | | |
| 1998 | 97 | 151 | Fair | | | | |
| 1999 | | | | 12* | 1,510* | | |
| 2000 | | | | | | 244 | 27,271 |
| 2001 | | | | | | 1,103 | 35,031 |
| 2002 | | | | | | 649 | 25,249 |
| 2003 | | | | | | 763 | 22,556 |
| 2004 | | | | | | 1,248 | 86,474 |

**Appendix 2. Brood year and age class distribution of Chinook salmon sampled at Henshaw Creek weir, Alaska, 2000-2004.**

| Population (N) | Sample (n) | Unknown Age | Brood year and age class | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
| | | | | **2000** | | | | | | | |
| | | | 1.5 | 1.4 | 1.3 | 1.2 | 1.1 | | | | |
| 244 | 38 | 0 | 0% | 18% | 63% | 18% | 0% | | | | |
| | | | | **2001** | | | | | | | |
| | | | | 1.5 | 1.4 | 1.3 | 1.2 | 1.1 | | | |
| 1,103 | 377 | 53 | | 1% | 45% | 42% | 12% | 0% | | | |
| | | | | **2002** | | | | | | | |
| | | | | | 1.5 | 1.4 | 1.3 | 1.2 | 1.1 | | |
| 649 | 347 | 39 | | | 2% | 31% | 36% | 30% | 0% | | |
| | | | | **2003** | | | | | | | |
| | | | | | | 1.5 | 1.4 | 1.3 | 1.2 | 1.1 | |
| 763 | 304 | 17 | | | | 2% | 33% | 44% | 19% | 2% | |
| | | | | **2004** | | | | | | | |
| | | | | | | | 1.5 | 1.4 | 1.3 | 1.2 | 1.1 |
| 1,248 | 636 | 34 | | | | | 1% | 26% | 28% | 45% | 0% |

**Appendix 3. Brood year and age class distribution of summer chum salmon sampled at Henshaw Creek weir, Alaska, 2000-2004.**

| | | | Brood year and age | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Population (N) | Sample (n) | Unknown age | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
| | | | | **2000** | | | | | | |
| | | | 0.5 | 0.4 | 0.3 | 0.2 | | | | |
| 27,271 | 519 | 61 | 0% | 42% | 57% | 1% | | | | |
| | | | | **2001** | | | | | | |
| | | | | 0.5 | 0.4 | 0.3 | 0.2 | | | |
| 35,031 | 627 | 162 | | 2% | 63% | 34% | 0% | | | |
| | | | | **2002** | | | | | | |
| | | | | | 0.5 | 0.4 | 0.3 | 0.2 | | |
| 25,249 | 732 | 142 | | | 4% | 80% | 16% | 0% | | |
| | | | | **2003** | | | | | | |
| | | | | | | 0.5 | 0.4 | 0.3 | 0.2 | |
| 22,556 | 696 | 86 | | | | 1% | 9% | 86% | 4% | |
| | | | | **2004** | | | | | | |
| | | | | | | | 0.5 | 0.4 | 0.3 | 0.2 |
| 86,474 | 773 | 81 | | | | | 0% | 7% | 86% | 7% |

**Appendix 4. Sex ratios and sample size of Chinook salmon sampled at Henshaw Creek weir, Alaska, 2000-2004.**

| Year | Total number of salmon estimated | Sample size (n) | Percent female of sample | Estimated number of females |
|---|---|---|---|---|
| 2000 | 244 | 94 | 20 | 39 |
| 2001 | 1,103 | 975 | 40 | 436 |
| 2002 | 649 | 347 | 31 | 201 |
| 2003 | 763 | 580 | 38 | 284 |
| 2004 | 1,248 | 636 | 23 | 287 |

**Appendix 5. Sex ratios and sample size of summer chum salmon sampled at Henshaw Creek weir, Alaska, 2000-2004. 2003 includes opportunistic sampling.**

| Year | Total number of salmon estimated | Sample size (n) | Percent female of sample | Estimated number of females |
|---|---|---|---|---|
| 2000 | 27,271 | 1,649 | 57 | 14,445 |
| 2001 | 35,031 | 1,557 | 61 | 21,214 |
| 2002 | 25,249 | 732 | 60 | 15,149 |
| 2003 | 22,556 | 14,266 | 50 | 10,700 |
| 2004 | 86,474 | 773 | 54 | 46,535 |

**Appendix 6. Mean length at age of female and male Chinook salmon sampled at Henshaw Creek weir, Alaska, 2000-2004.**

| | Female | | | | Male | | | |
|---|---|---|---|---|---|---|---|---|
| Age | N | Percent per sample | Mean (SE) | Range | N | Percent per sample | Mean (SE) | Range |
| | | | | **2000** | | | | |
| 1.1 | 0 | | | | 0 | | | |
| 1.2 | 0 | | | | 7 | 27 | 492 (14.0) | 460-550 |
| 1.3 | 5 | 42 | 812 (9.3) | 790-840 | 19 | 73 | 661 (12.9) | 545-750 |
| 1.4 | 7 | 58 | 830 (17.0) | 795-915 | 0 | | | |
| 1.5 | 0 | | | | 0 | | | |
| Total | 12 | | 823 (10.6) | 790-915 | 26 | | 616 (18.0) | 460-750 |
| | | | | **2001** | | | | |
| 1.1 | 0 | | | | 0 | | | |
| 1.2 | 0 | | | | 44 | 17 | 534 (8.9) | 450-740 |
| 1.3 | 24 | 21 | 787 (17.3) | 605-905 | 142 | 59 | 697 (5.6) | 490-860 |
| 1.4 | 108 | 79 | 830 (4.8) | 620-835 | 55 | 23 | 778 (7.2) | 640-885 |
| 1.5 | 4 | | 842 | 770-915 | 4 | 1 | 843 (37.8) | 770-915 |
| Total | 136 | | 826 (5.2) | 605-915 | 241 | | 686 (6.5) | 450-915 |
| | | | | **2002** | | | | |
| 1.1 | 0 | | | | 0 | | | |
| 1.2 | 1 | 1 | 540 | - | 104 | 43 | 521 (7.2) | 410-860 |
| 1.3 | 24 | 22 | 784 (13.4) | 610-890 | 101 | 42 | 699 (6.2) | 545-930 |
| 1.4 | 75 | 70 | 832 (6.3) | 715-975 | 34 | 15 | 797 (10.5) | 685-950 |
| 1.5 | 7 | 7 | 853 (22.0) | 740-920 | 1 | 0 | 895 (0.0) | - |
| Total | 107 | | 818 (6.4) | 540-975 | 240 | | 637 (8.1) | 410-950 |
| | | | | **2003** | | | | |
| 1.1 | 0 | | | | 5 | 3 | 376 (4.9) | 365-390 |
| 1.2 | 0 | | | | 59 | 32 | 508 (6.2) | 410-695 |
| 1.3 | 26 | 22 | 764 (10.1) | 695-875 | 108 | 58 | 690 (5.4) | 425-780 |
| 1.4 | 88 | 74 | 851 (6.4) | 580-955 | 13 | 7 | 830 (21.3) | 700-940 |
| 1.5 | 5 | 4 | 894 (10.4) | 860-915 | 0 | | | |
| Total | 119 | | 833 (6.3) | 580-955 | 185 | | 633 (8.8) | 365-940 |
| | | | | **2004** | | | | |
| 1.1 | 0 | | | | 1 | 0 | 375 | - |
| 1.2 | 12 | 8 | 644 (9.3) | 590-690 | 275 | 56 | 583 (2.6) | 400-680 |
| 1.3 | 23 | 16 | 704 (10.6) | 630-810 | 157 | 32 | 689 (5.0) | 520-880 |
| 1.4 | 108 | 73 | 845 (3.5) | 750-960 | 56 | 12 | 827 (7.7) | 715-950 |
| 1.5 | 4 | 3 | 880 (34.4) | 780-930 | 0 | | | |
| Total | 147 | | 807 (6.7) | 590-960 | 489 | | 645 (4.4) | 375-950 |

**Appendix 7. Mean length at age of female and male summer chum salmon sampled at Henshaw Creek weir, Alaska, 2000-2004.**

| | Female | | | | Male | | | |
|---|---|---|---|---|---|---|---|---|
| Age | N | Percent per sample | Mean (SE) | Range | N | Percent per sample | Mean (SE) | Range |
| | | | | **2000** | | | | |
| 0.2 | 3 | 2 | 525 (8.7) | 510-540 | 1 | 1 | 535 | - |
| 0.3 | 196 | 59 | 531 (1.7) | 445-600 | 104 | 55 | 561 (2.7) | 515-655 |
| 0.4 | 134 | 40 | 545 (2.4) | 430-615 | 80 | 43 | 581 (3.7) | 500-655 |
| 0.5 | 0 | | | | 1 | 1 | 570 | - |
| Total | 333 | | 537 (1.4) | 430-615 | 186 | | 570 (2.3) | 500-655 |
| | | | | **2001** | | | | |
| 0.2 | 1 | 0 | 480 | - | 0 | 0 | | |
| 0.3 | 149 | 36 | 532 (2.4) | 430-640 | 64 | 30 | 560 (4.5) | 480-650 |
| 0.4 | 254 | 62 | 559 (2.1) | 450-665 | 144 | 67 | 594 (3.6) | 520-725 |
| 0.5 | 8 | 2 | 547 (11.4) | 500-595 | 7 | 3 | 577 (8.4) | 550-620 |
| Total | 412 | | 549 (1.7) | 430-665 | 215 | | 583 (2.9) | 480-725 |
| | | | | **2002** | | | | |
| 0.2 | 1 | 1 | 520 | - | 0 | | | |
| 0.3 | 79 | 18 | 543 (3.5) | 450-630 | 35 | 12 | 577 (5.1) | 540-690 |
| 0.4 | 348 | 79 | 559 (1.3) | 465-635 | 241 | 83 | 594 (2.3) | 515-805 |
| 0.5 | 14 | 3 | 570 (6.0) | 540-600 | 14 | 5 | 589 (7.6) | 540-640 |
| Total | 442 | | 556 (1.3) | 450-635 | 290 | | 592 (2.1) | 515-805 |
| | | | | **2003** | | | | |
| 0.2 | 6 | 2 | 526 (11.9) | 495-570 | 2 | 1 | 585 (25.0) | 560-610 |
| 0.3 | 317 | 87 | 537 (1.5) | 465-625 | 281 | 84 | 563 (1.7) | 490-660 |
| 0.4 | 24 | 7 | 567 (5.9) | 495-615 | 35 | 10 | 596 (6.7) | 510-660 |
| 0.5 | 14 | 4 | 580 (6.0) | 530-610 | 17 | 5 | 633 (6.0) | 595-680 |
| Total | 361 | | 540 (1.5) | 465-625 | 335 | | 570 (1.9) | 490-680 |
| | | | | **2004** | | | | |
| 0.2 | 36 | 9 | 516 (4.6) | 460-580 | 21 | 6 | 540 (7.0) | 490-600 |
| 0.3 | 359 | 85 | 542 (1.4) | 450-655 | 302 | 86 | 562 (1.6) | 460-670 |
| 0.4 | 26 | 6 | 558 (5.6) | 500-600 | 29 | 8 | 604 (4.3) | 570-655 |
| Total | 421 | | 541(1.4) | 450-655 | 352 | | 564 (1.6) | 460-670 |